Wave measurement comparisons from moored buoys and light vessels

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Topics

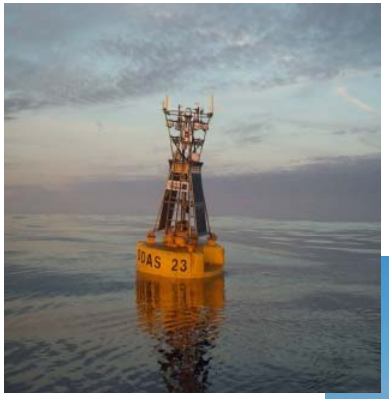
Preliminary results presented for:-

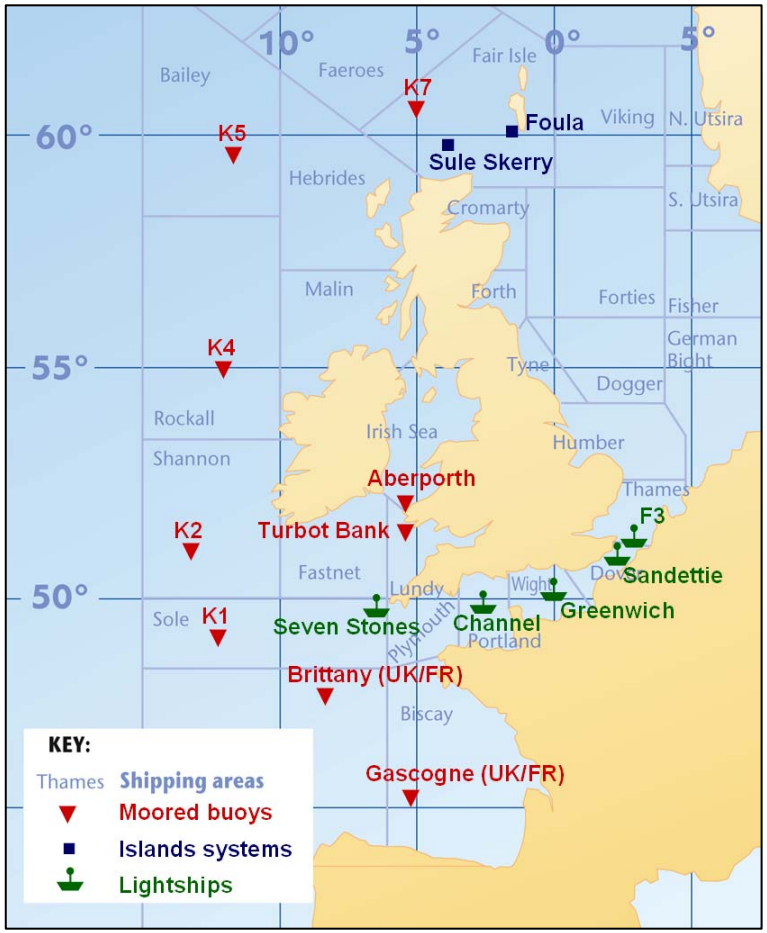
1. Comparison of wave measurements from moored buoys equipped with both Datawell heave sensor and Triaxys directional spectral wave sensor

2. Comparison of wave measurements from the Met Office moored buoys and instrumented light vessels (both are fitted with a Datawell heave sensor)

Marine Automatic Weather Station (MAWS) network

- Operational MAWS network presently comprises
  - 9 moored buoys
  - 5 light vessels
  - 2 remote islands





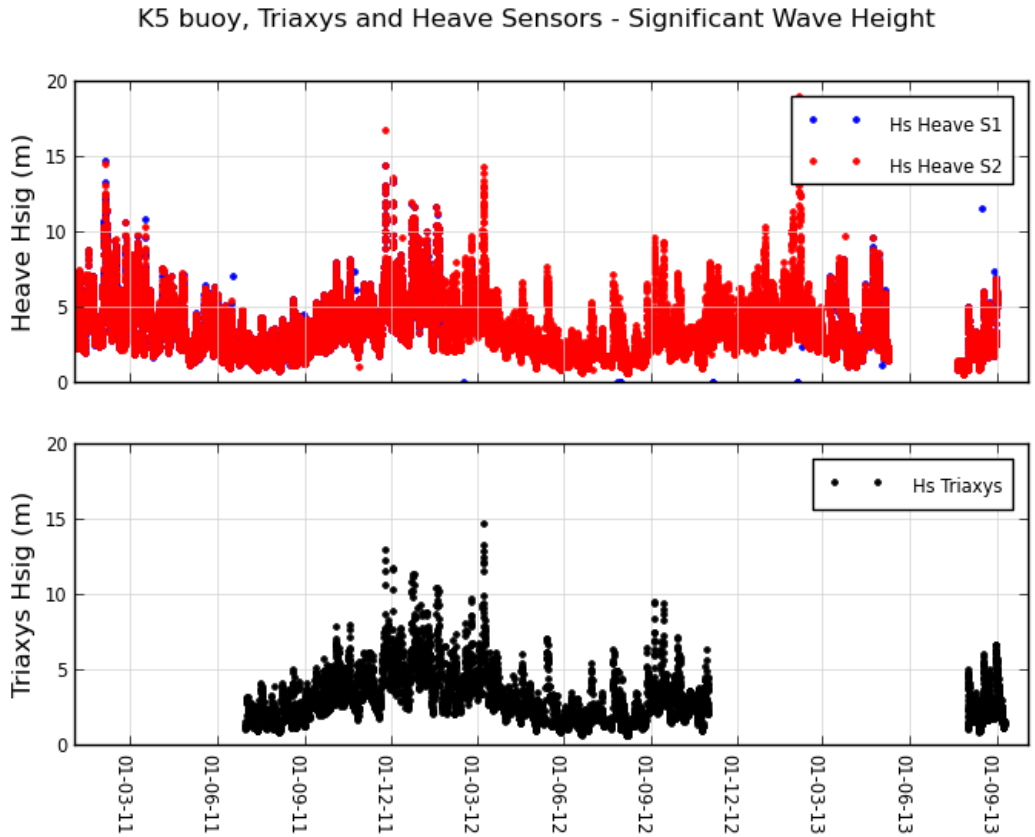
1. Heave/Triaxys comparison

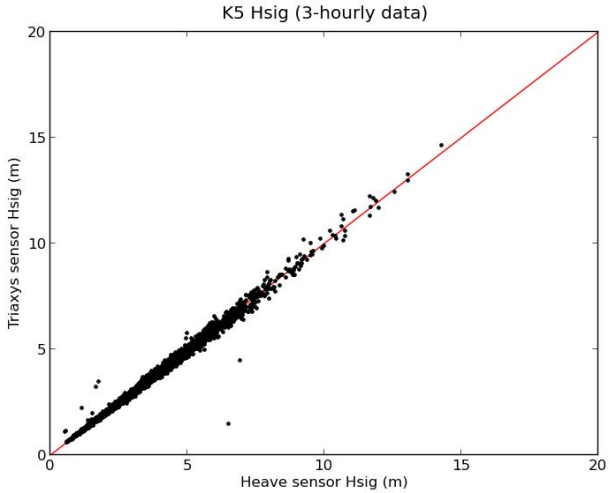
- Heave sensor has a 17½ minute sample whereas Triaxys has a 20 minute sample
- Quoted sensor errors are
  - Heave: <1% after 3 years (additional error of 1-2% due to use of scaling resistors)
  - Triaxys: < 2%
- So would expect differences to be within 5%

Triaxys wave data

- Triaxys installed on K5, Gascogne & Brittany alongside the Datawell heave sensor
- K5 from Jul 2011, Gascogne from Oct 2011 and Brittany from Nov 2011
- There are some data gaps due to system failures
- Have 519 days of Triaxys data for K5, 287 days for Gascogne and 380 days for Brittany

Hsig – K5





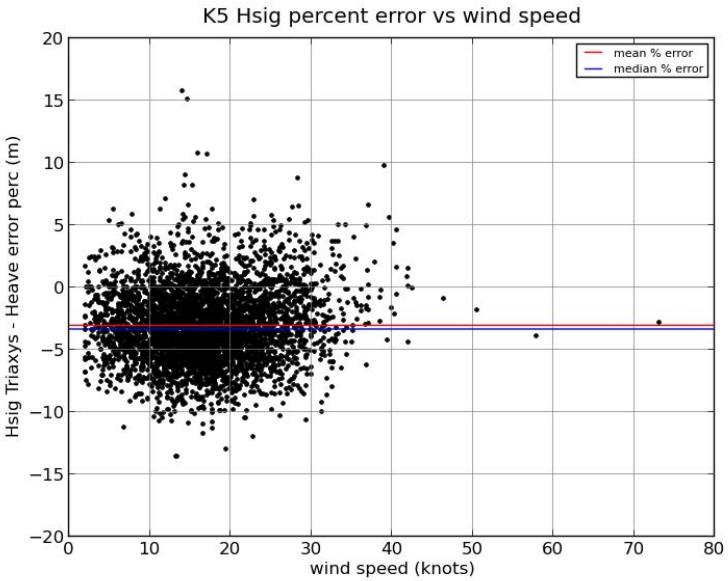
Mean difference (Triaxys-heave) -0.09 m

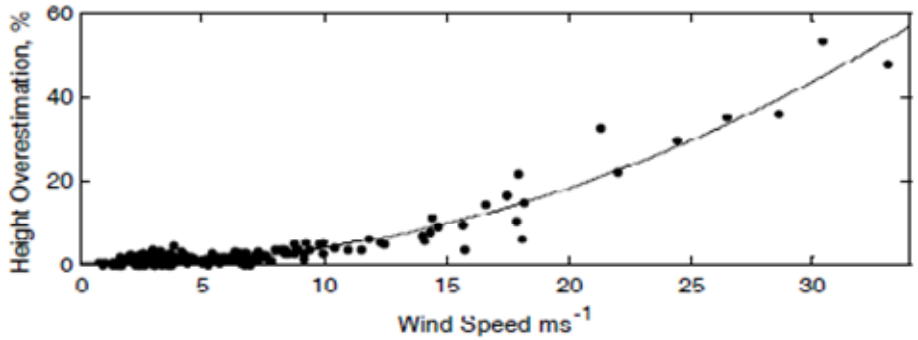
RMS difference 0.18 m

Heave data sub-sampled to every 3 hours

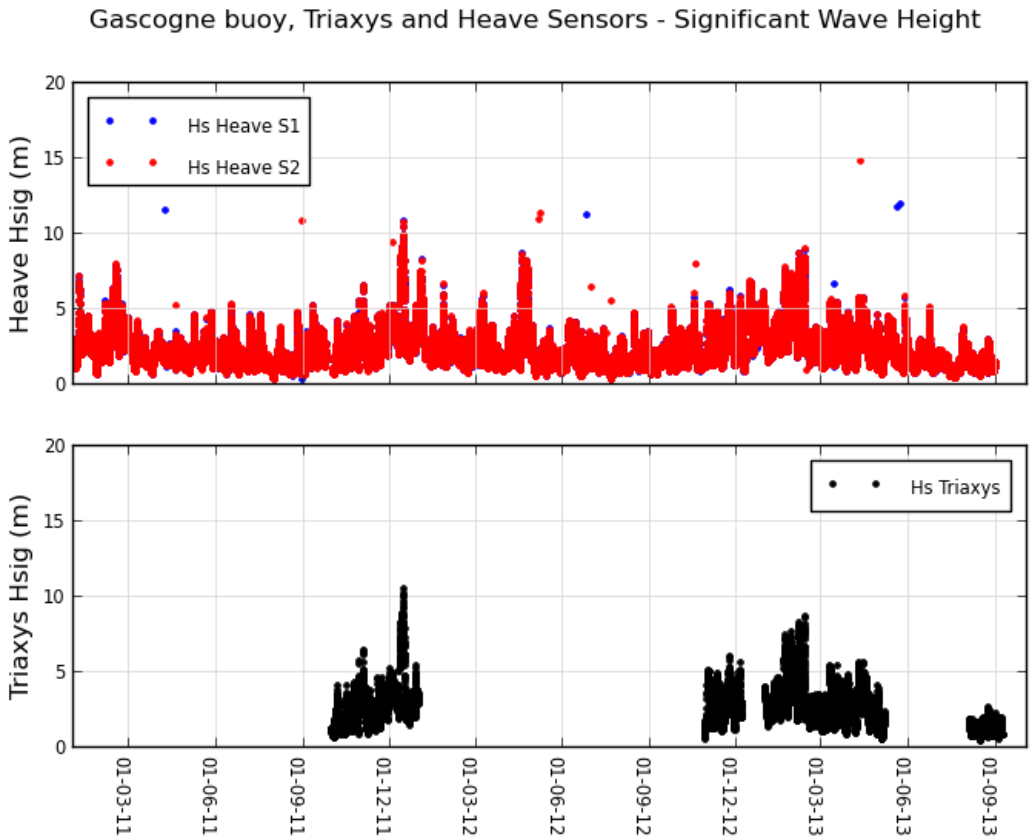
Effect of windspeed

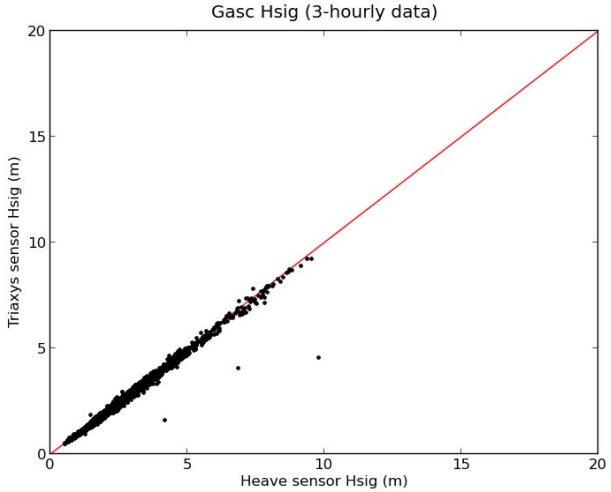
- No indication that the wave heights from the 1-D heave sensor are overestimated in high winds compared to the 3-D Triaxys
- Results do not show any buoy heeling effect as reported by Bender (2009), below





Hsig – Gascogne



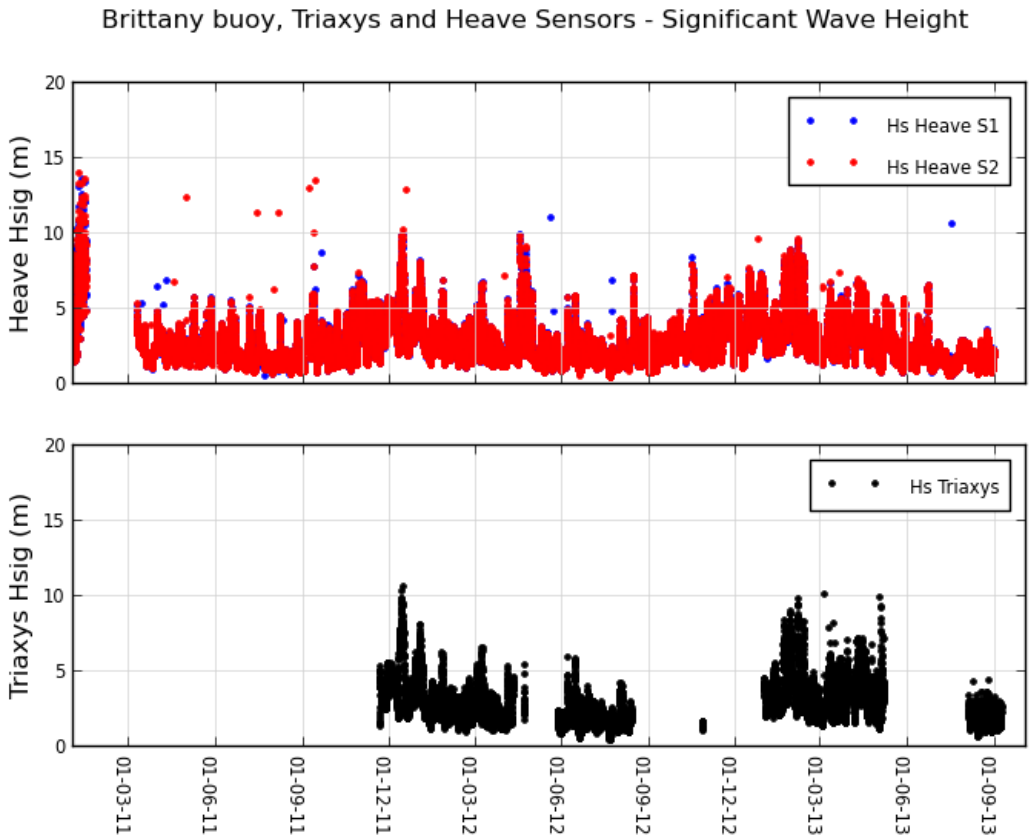


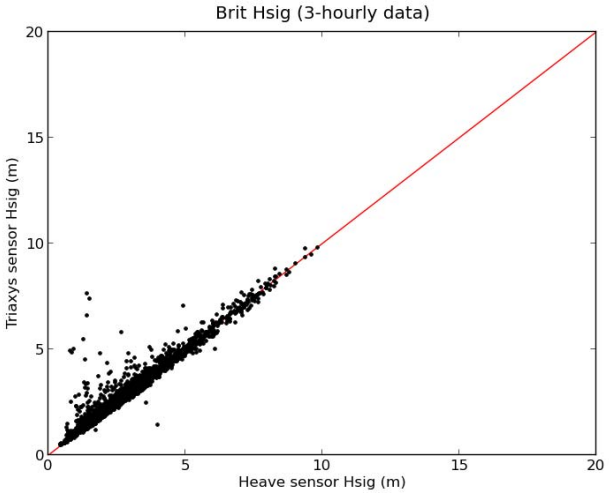
Mean difference (Triaxys-heave) -0.14 m

RMS difference 0.22 m

Data sub-sampled to 3 hourly

Hsig – Brittany





Mean difference (Triaxys-heave) 0.03 m

RMS difference 0.46 m

Data sub-sampled to 3 hourly

Hsig results summary

- K5 & Gascogne: Triaxys values slightly lower (0.09 m & 0.14 m) than heave (~3% and 5%)
- Brittany: Triaxys value slightly higher (0.03 m) than heave (~3%)
- K5 & Gascogne: RMS difference ~0.2 m, for Brittany ~0.5 m (some erroneous values ?)
- Can relate to RMS difference between Hs at t+0 and t+1hr which was 0.34 m (earlier analysis for K5 Aug 2008 to Oct 2009)

2. Light vessel wave measurements

Jean Bidlot (ECMWF), 2011 - “For many years I have been using wind and wave data from the UK buoys and lightships as we have received them via the GTS. I have always found that my wave model output over-estimated wave heights and under-estimated wave periods with respect to the lightship data from the English Channel. I had always assumed that it was down to my model resolution and lack of shallow water physics. Nowadays these limitations should have been mostly resolved but it is there.”

Andy Saulter (Met Office), 2011 - “We've been taking the lightships readings with a very heavy pinch of salt for quite a while now, and blaming the hull size. I'm sure that once upon a time I saw a reference to a report by Ted Pitt that suggested just this - but I've never found a copy and am beginning to think I just dreamt it!!”

Study approach

- Comparisons of both LV and buoy wave measurements (Hsig and Tave) against colocated output from the Met Office wave model to investigate whether there is a systematic difference between the measurements from the two systems
- Buoys used K4, K5, K7, Brittany, Aberporth & Turbot Bank; LVs Seven Stones, Channel, Greenwich & Sandettie (& Hastings waverider)
- Period of analysis 2011 and 2012 (two years)

Statistics (LVobs-model) for 2 year period

Light vessel	Number of obs	Mean difference (m)	RMS difference (m)
Seven Stones	2848	-0.30	0.48
Channel	2822	-0.33	0.44
Greenwich	1986	-0.43	0.55
Sandettie	2608	-0.28	0.51

Light vessel	Number of obs	Mean difference (s)	RMS difference (s)
Seven Stones	2840	2.15	2.59
Channel	2808	2.72	3.91
Greenwich	2882	8.36	12.36
Sandettie	2623	2.53	4.07

Hsig: LVobs lower than model

Tave: LVobs higher than model

Statistics (moored buoys-model)

Moored buoy	Number of obs	Mean difference (m)	RMS difference (m)
Aberporth	2887	0.14	0.36
Turbot Bank	2873	-0.02	0.29
Brittany	2660	0.03	0.49
K4	2808	-0.10	0.46
K5	2865	0.15	0.44
K7	1521	-0.06	0.53

Hsig: no consistent bias

Moored buoy	Number of obs	Mean difference (m)	RMS difference (m)
Aberporth	2887	0.65	1.03
Turbot Bank	2873	0.72	1.17
Brittany	2660	0.31	1.22
K4	2808	0.22	0.75
K5	2865	0.14	0.91
K7	1599	1.11	4.15

Tave: difference is much smaller

Moored buoy	Variable	Number of obs	Mean difference (m)	RMS difference (m)
Hastings waverider	Hsig	1324	0.11	0.21
	Tz	1324	0.37	0.60

Results similar to comparison against Hastings waverider buoy

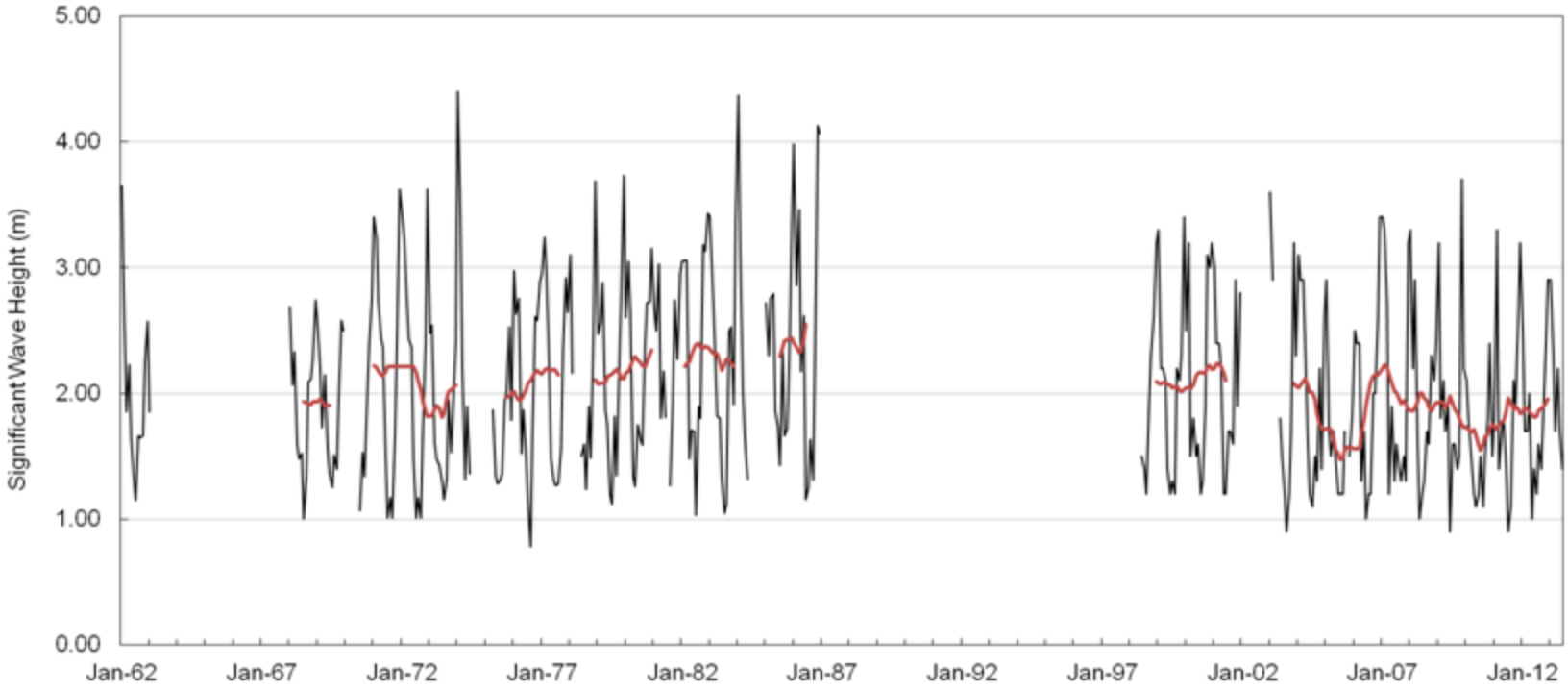
LV waves

- The results show there is generally reasonable agreement between the model and the moored buoys, but that the model consistently gives higher values of Hsig (and lower Tz) than reported from the LVs
- Suggests the wave observations from the LVs have a tendency (relative to the moored buoys) to underestimate Hsig by ~0.3 m and overestimate Tz by ~2 s
- To put this in perspective, at Seven Stones Hsig increased by ~0.02 m/year between 1962 and 1986

Seven Stones wave climate

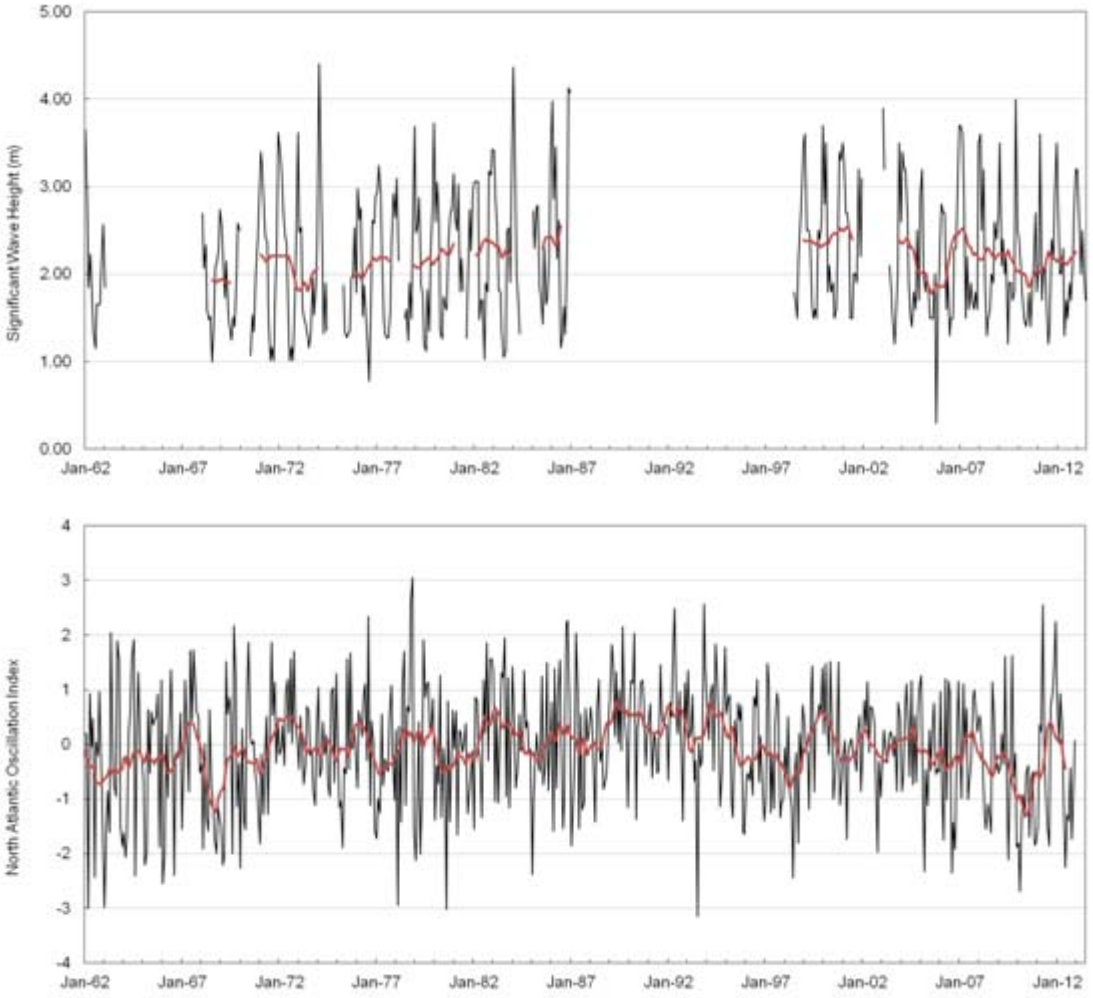
- The wave record at Seven Stones, which goes back as far as 1962, spanning over 50 years, is the longest time-series (albeit with some gaps) of wave measurements in UK waters.
- From 1962-1988 the measurements made by IOS using the SBWR
  - Used accelerometers to measure vessel heave and pressure sensors (below the waterline) to measure changes in the sea level relative to the vessel
  - Crisp (1987) indicated that for waves in the range 0.2 to 0.3 Hz the pressure and accelerometer channels make contributions of comparable magnitude to the total signal
- From 1998 measurements made by the Met Office using a Datawell heave sensor
  - Suggests present measurements would underestimate wave height as the inertia of the vessel is not taken into account

Seven Stones wave climate



- Monthly mean SWH with a 12-month smoothed trace overlaid
- Wave heights increased by ~0.02 m/year between 1962 and 1986
- Indication that wave heights have decreased since the late 90s

North Atlantic Oscillation



Wave heights from 1998 have been adjusted by +0.3m to compensate for underestimation of Hsig

Altimeter data suggest the increase in wave height continued into the early 90s

Wave heights have been correlated with the North Atlantic Oscillation (NAO) index by various workers

Adjusted data are (more) consistent with an increase in wave heights from 1962 to the early 90s

After which the NAO index has decreased, with an associated decrease in wave heights.

LVwaves summary

- Results suggest that wave measurements from the light vessels made since the late 90s with a heave sensor have underestimated Hs by ~0.3m, which is comparable to a 15 year change at Seven Stones
- Measurements suggest wave heights at Seven Stones have decreased over the last 15 years